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Nailing Drug and Alcohol Testing: The Use of Fingernails as an Alternative to Hair Testing

Substance abuse in the 21st century is an ever-evolving and sophisticated animal. Through the Internet, new drugs—both illicit and prescription—are available in dizzying arrays. Along with the new drugs being abused are new methods to avoid detection. Labs must maintain constant research and development to meet the needs of the ever-changing market. Thankfully, the old adage ‘you are what you eat’ still rings true.

Hair testing has caught on as a popular sample to detect substances of abuse and so has the ability of the abuser to Google ways to offset drug tests. In an effort to remain ahead of the curve in this complex market, researchers have turned to other sample types to go beyond the limits of hair testing. Fingernails are composed of keratin, the same protein matrix found in hair. Fingernail testing has many similarities to hair testing, as well as some advantages including ease of collection, stability, and a longer window of detection.

Incorporation of Drug and Alcohol Biomarkers in Nail Samples

Fingernail keratin is four times thicker than that found in hair. While hair grows only in length from the hair root, nail keratin grows in two directions. From the germinal matrix, fingernails grow in length as they emerge from the nail root. As they elongate, fingernails also grow in thickness with new keratin being added to the underside of the fingernail along the nail bed (Figure 1).

It was previously thought that substances could only enter the fingernail from the germinal matrix, but research on therapeutic drug monitoring has debunked this model of drug capture. Blood vessels in the nail bed continuously feed the growing fingernail. As a result, drug and alcohol biomarkers are trapped in the keratin matrix over the entire fingernail as it grows in length.

Fingernails are a reservoir matrix made up of a tight weave of keratin fibers that are also porous. This tight but porous nature means that nails are a superb matrix for catching and trapping drug and alcohol biomarkers. Chronic drug or alcohol use causes a continuous build-up of biomarkers along the entire fingernail as it grows.

Detecting Drugs in Fingernails

Amphetamine and methamphetamine were the first illicit substances to be detected in nail samples in 1984. The role of nails in other uses like environmental exposure analysis, forensics, poison investigation, and others extends as far back as the 1800s. Much of what is known about the drugs in fingernails comes from drug therapy monitoring, most notably early studies into the antifungal treatment of toenails. Despite gaining acceptance as a tool for alcohol and substance abuse detection in recent decades, the body of evidence supporting fingernail testing spans nearly two centuries.

Drug and alcohol use can be detected in fingernail samples 1–2 weeks following use. In that time, the leading edge of the fingernail can grow out to a length that gives sufficient quantity for testing. The window of detection for drugs in fingernails is from three months up to six months after use, depending on several factors. The rate of fingernail growth can vary from person to person and can be
affected by age (slower growth in older persons), disease state, and even weather (fingernails may grow slower in colder weather). Some drugs may wash out of fingernails as quickly as three months after use; yet, other drugs can have a much longer retention time. Despite this variability, research has shown that the window of detection for drug use in fingernails is at least equivalent to that of hair, and for many drugs the look-back is much longer than for hair.

The same drugs that can be detected in hair samples can also be detected in fingernails. In some cases, fingernails may capture more of a drug than is typically found in hair samples. For example, a 2013 study found that fingernail samples positive for carboxy-THC (a marijuana metabolite) captured five times more of the biomarker than positive hair samples. Fingernails are able to remove the variation in results caused by hair pigment for some drugs. For instance, the same dose of amphetamine may give a 30-fold difference in the amount detected in blonde hair versus black hair. This is due to variation in test results for some drugs caused by differences in hair pigment. Fingernail testing removes this variation. Research comparing fingernails and hair for other drugs has shown the two sample types to be equivalent, although the comparison has not been made for all potential substances of abuse. These various studies suggest that fingernail testing is a suitable, and in some cases superior, alternative to hair testing.

If a donor’s fingernails are not of sufficient length, waiting 7–10 days will allow enough fingernail growth to give the ideal sample size. Because a donor’s drug and alcohol use impacts the entire length and width of the fingernail, this new growth will still capture a 3–6 month history of drug use. In contrast, a three-month window of detection in hair can only be achieved if the donor already has at least 1.5 inches of hair on the head. Any new hair growth will not contain any history of previous drug or alcohol use.

**Alcohol Testing in Fingernails**

Alcohol testing in fingernails, as in hair, is done through the analysis of ethyl glucuronide (EtG), a direct alcohol biomarker. EtG is known as a direct biomarker, because it is only produced by the body when ethanol is present. This is in contrast to indirect biomarkers such as aspartate aminotransferase (AST), gamma glutamyl transferase (GGT), or carbohydrate deficient transferin (CDT), among others. Indirect markers measure the effects of ethanol consumption on the health of the body. Other conditions may confound indirect biomarkers, such as age or certain diseases. Ethanol is converted to EtG in the liver and then deposited in fingernails primarily from the nail bed capillaries.

The use of fingernail samples for EtG testing may be a preferred sample type over hair for two reasons. First, EtG accumulates at higher concentrations in fingernail samples. EtG testing in fingernails eliminates a possible bias seen in hair EtG testing as well. A 2012 study compared EtG levels in paired fingernail and hair samples taken from 606 college students. EtG levels in positive fingernail samples were 2.5 times higher than those detected in positive hair samples.

The college student data also suggested a possible bias for EtG testing in hair samples; fingernail and hair samples taken from male subjects showed strong agreement in their positivity rate. However, there was very little agreement between the two sample types for female subjects. Earlier research from 2010 demonstrated that EtG in hair could be broken down as a result of some cosmetic hair treatments, such as hair bleaching and dyeing, which may account for the difference between the two sample groups (Figure 2 and 3).

**Sample Collection**

Fingernail testing offers several advantages in sample collection. Fingernail samples are clipped from the leading edge of the growing nail and are the least intrusive of any testing sample. Fingernails can be collected by the donor themselves in front of a trained observer, as opposed to hair samples which need to be taken by a trained collector. Additionally, the collection of fingernails has very low impact on the personal appearance of the donor, which is not always true when hair samples are collected. Fingernails are almost universally available, which may not be true for donors experiencing hair loss and thinning.

An ideal sample size for screening and confirmation of positive results is 100 mg of fingernails. A 2–3 mm clipping—about the width of the edge of a U.S. Quarter—from all ten fingernails will give the optimal sample size.

**Conclusion**

Substance abuse in the 21st century is complicated. Detection methods must be open to alternative samples to keep up. Fingernails offer a drug and alcohol testing sample that is a useful, and in many ways superior alternative to hair testing. The rate of growth of fingernails, coupled with the stability of drugs in the nail keratin matrix, provides the longest
window of detection of any drug testing sample. Because they grow in both length and thickness, fingernails preserve their window of detection in a greater surface area, and allow for greatest accessibility to drug and alcohol use history. Well-researched and long-used for various forensic applications, fingernails are a powerful tool to be included in the drug and alcohol testing professional’s toolbox.

**References**


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